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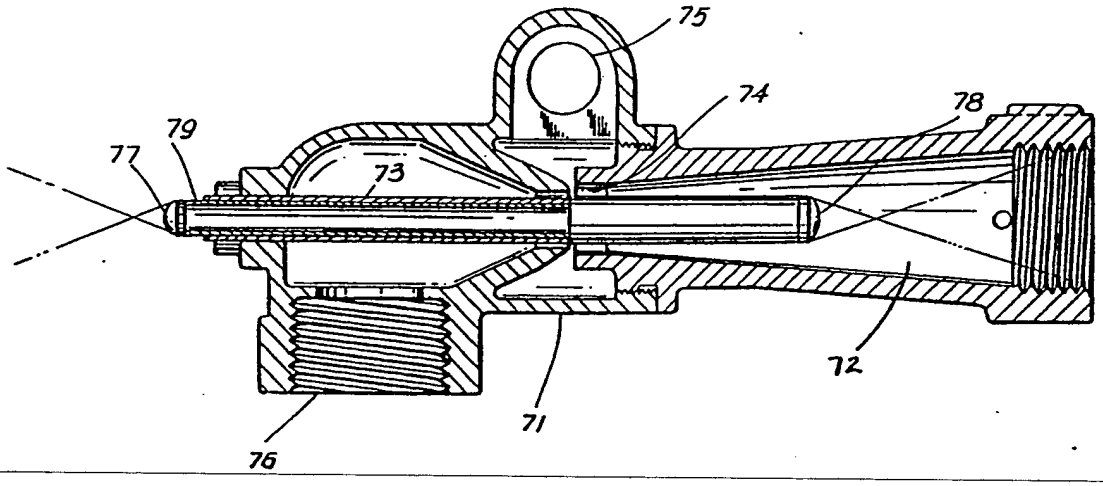

(57) Abstract

Burners with a flame observation mixer (71, 72) providing substantially complete combustion and a uniform flame composition using a wide variety of fuels including low pressure gaseous and liquid fuels and a method for using these burners to melt copper cathodes in a vertical shaft furnace are disclosed.

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METHOD AND BURNER FOR MELTING COPPER

BACKGROUND OF THE INVENTION

This invention relates to burners which provide substantially complete combustion and a uniform flame composition using a wide variety of fuels including low pressure gaseous and liquid fuels and to a method for using these burners to effectively and efficiently melt copper cathodes in a vertical shaft furnace without incorporating unwanted amounts of oxygen into the copper.

The need for burners providing efficient heating and melting is a very important industrial concern, especially today when energy costs are rising, supplies of fuel are decreasing and the types of fuels available for use are changing. The melting of copper cathodes in a vertical fuel-fired furnace is one example of the need for new burners capable of using liquid fuels and fuels such as Blue water gas, carburetted water gas, reformed natural gas, natural gas, coke oven gas, oil gas, producer gas and other natural and manufactured gases. These gaseous fuels are usually taken directly from low pressure city gas systems and because pressure boosters are not usually permitted, existing burners employing high pressure gases cannot be effectively used for these applications.

As is well-known in the art and as discussed

in U.S. Patent No. 3,199,977 issued to A. J. Phillips et al. on August 10, 1965, the disclosure of which is incorporated by reference, copper cathodes are produced industrially by electrolytic processes. The cathodes are commercially pure copper and are generally flat rectangular shapes about one inch thick by about 25 inches to 40 inches, although larger or smaller sizes may be produced.

Although the cathodically deposited copper is commercially pure except for the usual impurities and unavoidable minor amounts of electrolyte (sulphates) physically present on the surface of the cathodes or occluded therein, the copper cathodes generally are not used per se because of their shape and physical properties, especially the grain structure of the deposited copper. To place them in more useful form, the cathodes must be melted and the molten metal cast into one or more semi-finished forms--for example, cakes, ingots, bars such as wire bars, billets and rods and similar shapes from which finished products are produced, such as for example, sheets, wire, tubes, and the many other commercial products fabricated of commercially pure copper. Moreover, if the copper becomes contaminated with commercially unacceptable amounts of oxygen and sulphur during the melting, it is essential that the sulphur and oxygen in the molten copper be reduced to acceptable amounts by blowing and poling before the molten metal is cast. From a commercial standpoint however, the melted copper is essentially ruined and cannot be used and must be reprocessed through a series of steps to form a new cathode. This is a costly and time consuming procedure.

It is essential therefore, that the burners used to melt the copper not contaminate the copper with, for example unwanted oxygen. In general, the fuel-oxygen (air) mixture is proportioned to contain insufficient oxygen to completely burn the fuel and the

resulting melting flame is a reducing flame. The critical nature of the melting stream (flame) requires however, that even though the total stream is reducing, unwanted oxidizing effects caused by the presence of unburned oxygen in the flame must be avoided. For most industrial uses, the predetermined reducing conditions should be such that any oxygen incorporated into the copper is less than .05% by weight of the copper during the melting. Preferably, the predetermined reducing conditions are such that less than .035% and most preferably less than .01% by weight of oxygen are incorporated into the molten copper.

The burners described in Phillips et al. supra and U.S. Patent No. 4,536,152 to Little et al. were specially designed to provide such a uniform reducing flame and a commercially pure melted copper product with the burner being shown in Fig. 1. The disclosure of U.S. Patent No. 4,536,152 is hereby incorporated by reference.

The prior art burner body 3 shown in Fig. 1 is comprised of a mixing section 50 for uniting a stream of fuel and a stream of an oxygen-containing gas (air) to form a unit stream and for introducing the unit stream into flame holder section 51. The burner body is also provided with a combustion chamber section 52 and is mounted on flange 53 against shoulder 54 of flame holder section 51. Igniter bar 58 may be disposed in the throat, and a conventional electrically activated spark plug 59 for igniting the unit stream is mounted on the side of section 51 with the inner end of the spark plug disposed adjacent bar 58. The combination of the throat and bar 58 are especially useful in maintaining combustion of the unit stream in combustion chamber 52, particularly at high fuel velocities. Section 51 is also provided with openings 69 and 70 for taking samples of the unit stream.

Section 50 has an annular manifold portion 60,

sleeve 61, bend or elbow portion 62, orifice plate 63 and observation port 64 provided with transparent eyepiece 65. Sleeve 61, which abuts shoulder 66 and the left end of section 50, cooperates with annular portion 60 to provide a manifold for introducing the smaller of the two streams to be united (usually the fuel stream) from pipe 36 through openings 67 into uniting chamber 68; the size and distribution of openings 67 about the periphery of the sleeve being selected to control entry to the fluid into the chamber. The larger stream is introduced to chamber 68 from pipe 29 through the orifice in plate 63 and bend portion 62. Pipe 36 conducts the smaller stream (fuel) to the burner body and is provided with a valve 39 for controlling the amount of fuel delivered at positive pressure to the burner body. Pipe 36 is provided with a conventional diaphragm controlled valve 38 having tube 37 leading from inside pipe 29 to the space above the diaphragm in the diaphragm means so as to communicate the pressure of the air in pipe 29 to the diaphragm. Normal operating pressures for the fuel gases are 1.25 to 2 pounds per square inch gauge (psig) and higher.

In operating the burner body, the larger stream of the two streams to be united is conducted to the burner body through an orifice into a bend leading to the uniting chamber, and the precise composition of the stream is determined in the manner disclosed in U.S. Pat. No. 3,199,977.

Unfortunately, however, the use of low pressure gaseous fuel and/or liquid fuels, which fuels have a line pressure less than the pressure exiting in the burner body, require modifications to the prior art burners and special operating conditions and a new burner design adapted to use these fuels is very much desired by industry.

SUMMARY OF THE INVENTION

This invention provides a highly effective

burner for melting metals without significant contamination of the metals and which is capable of using a wide variety of fuels including low and high pressure gaseous fuels and liquid fuels. The burner is an improvement of the burners described in U.S. Patent Nos. 3,199,977 and 4,536,152 and employs an aspirator mixer in place of the pressure mixing section of the prior art burners, which aspirator mixer allows the use of fuels having a pressure less than the pressure, e.g., air pressure, in the burner. For example, the prior art burners normally require a 12-15 inches of water pressure higher than the air pressure to operate. Using the aspirator burner of the invention, the fuel pressure may be less than the air pressure.

Another improvement is the inclusion of an eyepiece aligned axially with the mixing chamber of the burner and which may be positioned in a displacement rod used to form the aspirator orifice in the mixer section of the burner. The eyepiece preferably has a wide angle viewing lens to provide a wide angle view of the burner chamber walls. A more preferred embodiment utilizes a telescoping viewing instrument desirably positioned in the displacement rod for focusing on certain parts of the burner and even the furnace interior.

DESCRIPTION OF THE DRAWINGS

Fig. 1 is an enlarged vertical section view describing the prior art burner assembly;

Fig. 2 is a section of the aspirator mixer section of the burner of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The prior art burner shown in Fig. 1 and as discussed hereinabove is comprised of a number of sections and parts. The improved burner comprises replacing at or near point A of Fig. 1 the mixing section 50 and bend portion 62 with the mixing section 71 of the invention as shown in Fig. 2. Mixing section 71 can be secured at point A by a threaded connection,

flange, or other mechanical seal. Tube 37 of Fig. 1 which leads to diaphragm control valve 38 would preferably be retained and, in a more preferred embodiment, a similar tube would be connected at the end of the mixing section 71 near point A. This tube would be connected in a tee fitting with tube 37 to provide a pressure indication to the valve 38 and increased control of the burner operation.

As can be seen in Fig. 2, mixing section 71 is comprised of a mixing chamber 72 having optionally disposed therein, displacement rod 73 which forms an annular orifice 74. The smaller of the two streams to be united (usually the fuel stream) is introduced at inlet port 75 with the larger stream (usually the air stream) being introduced through inlet port 76. Eyepieces 77 and 78 are disposed at the ends of the displacement rod 73, with eyepiece 78 preferably being a wide-angle lens capable of viewing the complete interior of the igniting section 51 and combustion chamber 52. A highly preferred embodiment employs a telescopic section 79 disposed in displacement rod 73 for focusing on specific parts of the burner 3 and even the interior of the furnace.

In operating the burner, natural gas was used as the fuel and introduced through inlet port 75 with air being introduced through inlet port 76. The mixing section 71 was North American Mfg. Co. (Cleveland, Ohio) Aspirator Air Gas Mixer No. 3065-6 without a displacement rod. Dimensions of the burner may be found in their brochure entitled "Dimensions 30.65, 1-87", pages 1 and 2. The aspirator provided approximately 1.1 million BTU per hour of natural gas at 20 inch water column (W.C.) air pressure drop across orifice 74. The orifice annular area was 1.290 square inches. The pressure of the natural gas was .28 psig and the air pressure was .87 psig.

Measurement of the fuel-air mixture at

openings 69 and 70 showed a uniform mixture indicating that the flame in combustion chamber 52 would likewise be uniform and provide melting without the introduction of unwanted oxygen into the material being melted. This was confirmed when the burner was used to melt cathode copper in an industrial shaft furnace. Exemplary oxygen contents of the cathode and finished product were .01% and .02%, respectively.

It will be apparent that many changes and modifications of the several features described herein may be made without departing from the spirit and scope of the invention. It is therefore apparent that the foregoing description is by way of illustration of the invention rather than limitation of the invention.

C L A I M S

1. A method for melting copper in a shaft furnace wherein a burner is used to provide a flame which melts the copper comprising using an aspirator air/fuel mixer as part of the burner.

2. The method of claim 1, wherein the burner contains an eyepiece in the mixing section of the burner, the eyepiece being aligned axially with the mixing chamber of the burner.

3. The method of claim 2, wherein the eyepiece is in the form of a telescope which may be adjusted to view desired sections of the burner.

4. An aspirator air/fuel mixer burner containing an eyepiece positioned to view out through the mixing chamber outlet.

5. The burner of claim 4, wherein the eyepiece is positioned axially with the mixing chamber of the burner.

6. The burner of claim 5, wherein the eyepiece is enclosed within an axially positioned rod of the burner, the rod serving to form an annular aspirator section in the burner.

7. The burner of claim 6, wherein the eyepiece is part of a telescope device which can be adjusted to view different parts of the burner and furnace interior.

AMENDED CLAIMS

[received by the International Bureau on 22 November 1989 (22.11.89)
original claims 1,4 and 6 amended; other claims unchanged (1 page)]

1. A method for melting copper in a shaft furnace wherein a burner having a flame holder section ad a combustion chamber is used to provide a flame which melts the copper comprising using an aspirator air/fuel mixer to supply the air/fuel mixture to the flame holder section and the combustion chamber of the burner.

2. The method of claim 1, wherein the burner contains an eyepiece in the mixing section of the burner, the eyepiece being aligned axially with the mixing chamber of the burner.

3. The method of claim 2, wherein the eyepiece is in the form of a telescope which may be adjusted to view desired sections of the burner.

4. An aspirator air/fuel mixer burner for use in the method of claim 1 containing an eyepiece positioned to view out through the mixing chamber outlet.

5. The burner of claim 4, wherein the eyepiece is positioned axially with the mixing chamber of the burner.

6. The burner of claim 5, wherein the eyepiece is enclosed within an axially positioned tube of the burner, the tube serving to form an annular aspirator section in the burner.

7. The burner of claim 6, wherein the eyepiece is part of a telescope device which can be adjusted to view different parts of the burner and furnace interior.

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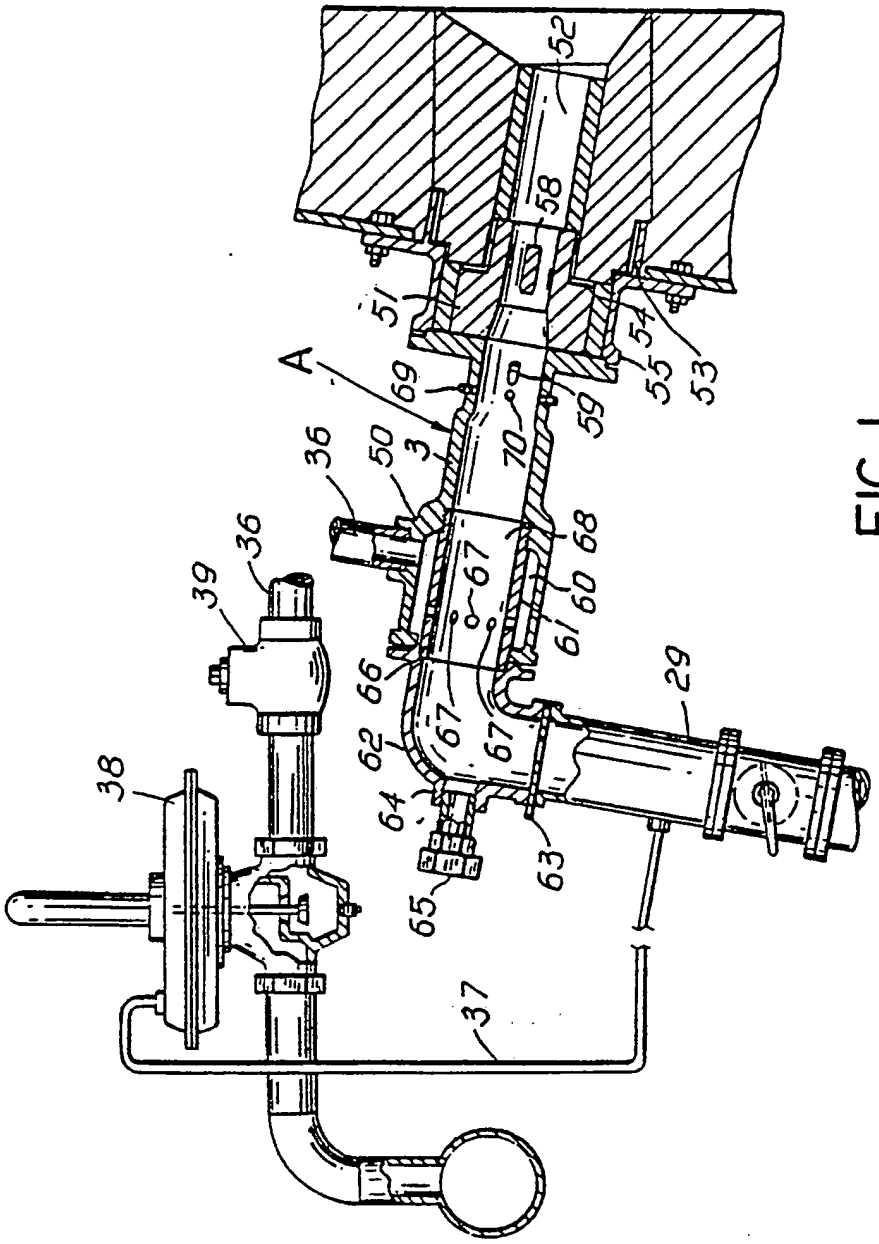
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FIG. 1

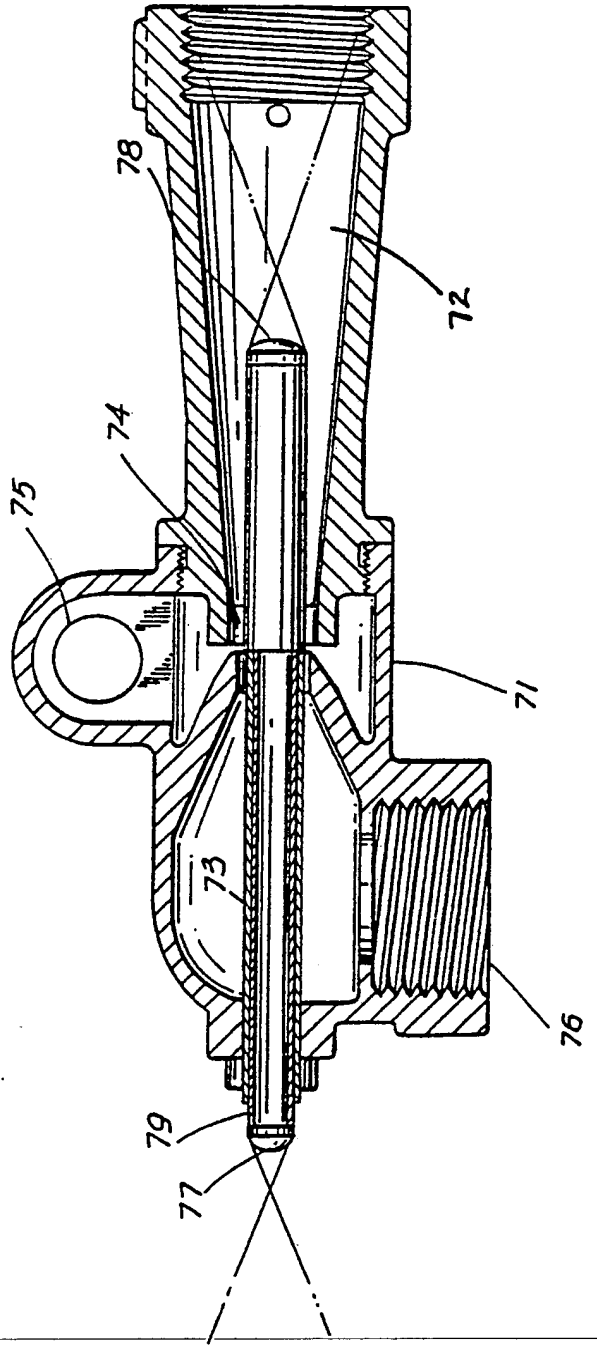

FIG.2

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US89/03268

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4] F23D 14/62
U.S. CL. 431/13

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S. CL.	431/13,75,79,159,354 266/100 75/72 432/95,97

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 3,199,977, (PHILLIPS ET AL), 10 August 1965	1
Y	US, A, 1,466,356, (EDDISON), 28 August 1923	1,4-7
Y	US, A, 1,618,486, (SKLOVSKY), 22 February 1927	2,3,4-7
Y	US, A, 3,545,903, (McCULLOUGH), 8 December 1970	2,3
A	US, A, 3,021,386, (CLARK), 13 February 1962	
A	US, A, 2,113,450, (LASKY ET AL), 5 April 1938	
A	US, A, 2,399,116, (HANSON), 23 April 1946	
A	US, A, 4,311,519, (BERRY), 19 January 1982	
A	US, A, 3,486,835, (GROBE), 30 December 1969	
A	US, A, 3,990,835 (BURTON, III), 9 November 1976	

* Special categories of cited documents: [10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

29 August 1989

Date of Mailing of this International Search Report

05 OCT 1989

International Searching Authority

IS/US

Signature of Authorized Officer

Carl D. Price

Form PCT/ISA/210 (second sheet) (Rev.11-87)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 4,536,152, (LITTLE, JR. ET AL) 20 August 1985	